

## PATTERNED SOI BY OXYGEN IMPLANTATION

### Introduction

It is well known that SOI based logic circuits show 20-30% higher performance than those comparably made on bulk-Si. One way to exploit this performance advantage is to fabricate ICs on patterned SOI substrates, such that logic circuits are fabricated on the SOI region whereas memories are fabricated on the bulk-Si region. Furthermore, both analog and digital circuits can be formed on SOI regions by controlling the thickness of the Si film. The patterning process also allows the formation of field isolation regions at desired locations.

### Process

Patterned SOI regions in this invention are created by implanting high doses of oxygen through a dielectric mask. In one variation, the oxygen implant and subsequent annealing conditions are equivalent to those used for standard medium or low-dose SIMOX. In another variation, the SOI regions are formed by the newly invented DIBOX process.

### Patterned Structures

Five kinds of patterned SOI structures are made by adjusting oxygen beam energy, oxygen dose, and the mask material :

- (i) an SOI region with the Si film thickness suitable for partially depleted devices and circuits (Fig. 1)
- (ii) an SOI region with Si the film thickness suitable for fully depleted devices and circuits (Fig 2)
- (iii) an SOI region with Si thicknesses suitable for both partially and fully depleted devices, and their circuits (Fig. 3)
- (iv) an SOI region with Si thickness suitable for partially depleted devices and circuits, along with an implantation induced isolation region (Fig 4)
- (iv) an SOI region with Si thickness suitable for fully depleted devices and circuits, along with an implantation induced isolation region (Fig 5).

In order to minimize surface topology on patterend regions, it is desirable to remove the dielectric mask after the oxygen implantation but before SIMOX or DIBOX annealing. Figures 6 and 7 show TEM cross-sections of a mask edge region after SIMOX and DIBOX annealing, respectively. Surface topology is within 100 Å.

In some cases it may be desirable to perform SIMOX or DIBOX annealing with the patterned mask in place, such as those which require trenches.

### Claims

Five kinds of patterned SOI structures are claimed by oxygen implantation of a patterned bulk-Si substrate :

- (i) a patterned SOI region with the Si film thickness suitable for partially depleted devices and circuits
- (ii) a patterned SOI region with Si the film thickness suitable for fully depleted devices and circuits

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(iii) a patterned SOI region with Si thicknesses suitable for both partially and fully depleted devices, and their circuits

(iv) a patterned SOI region with Si thickness suitable for partially depleted devices and circuits, along with an implantation induced isolation region

(iv) a patterned SOI region with Si thickness suitable for fully depleted devices and circuits, along with an implantation induced isolation region

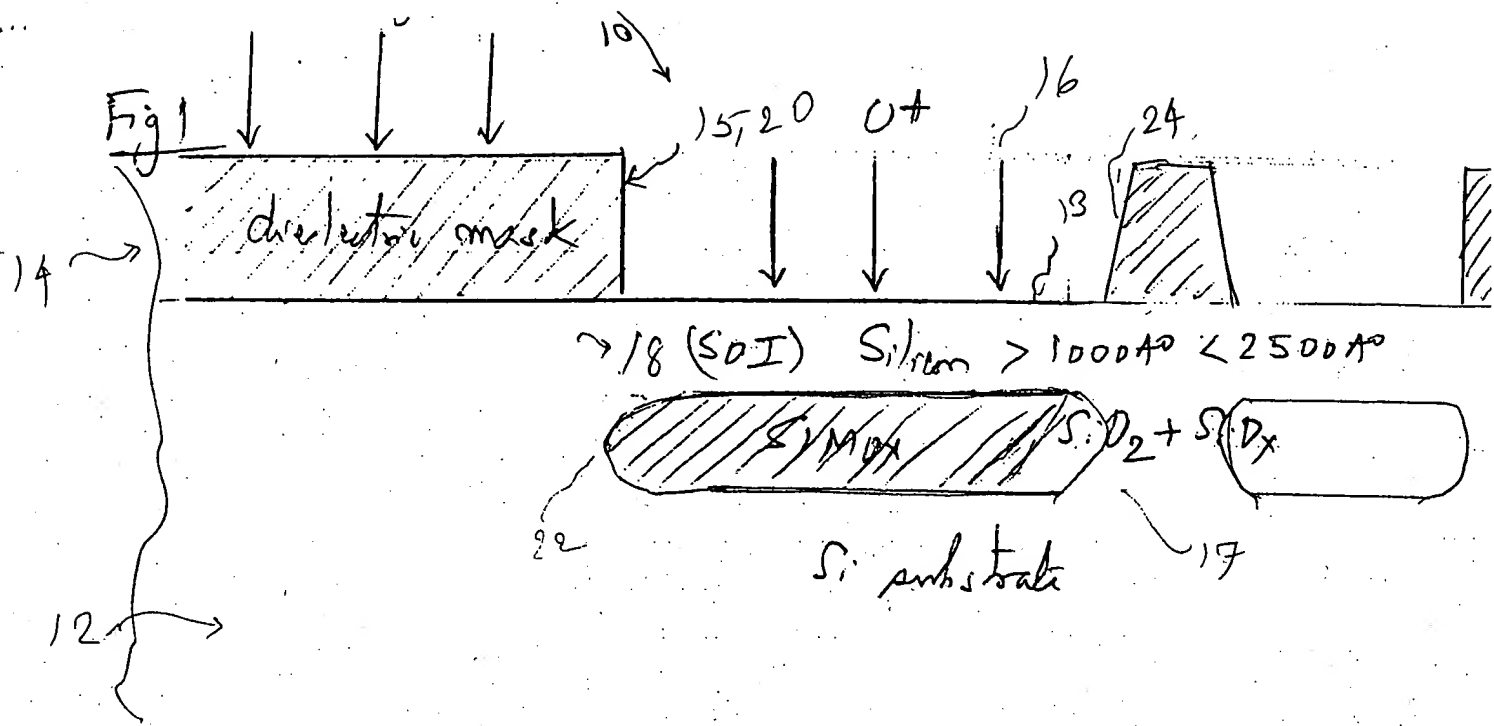
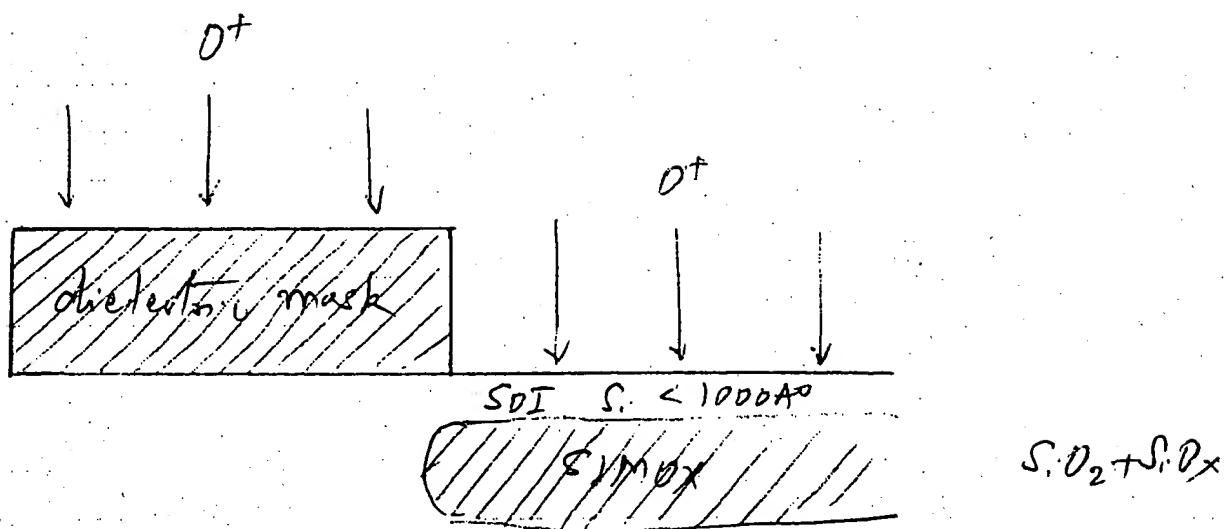


Fig. 2



Si substrate

Figure 3

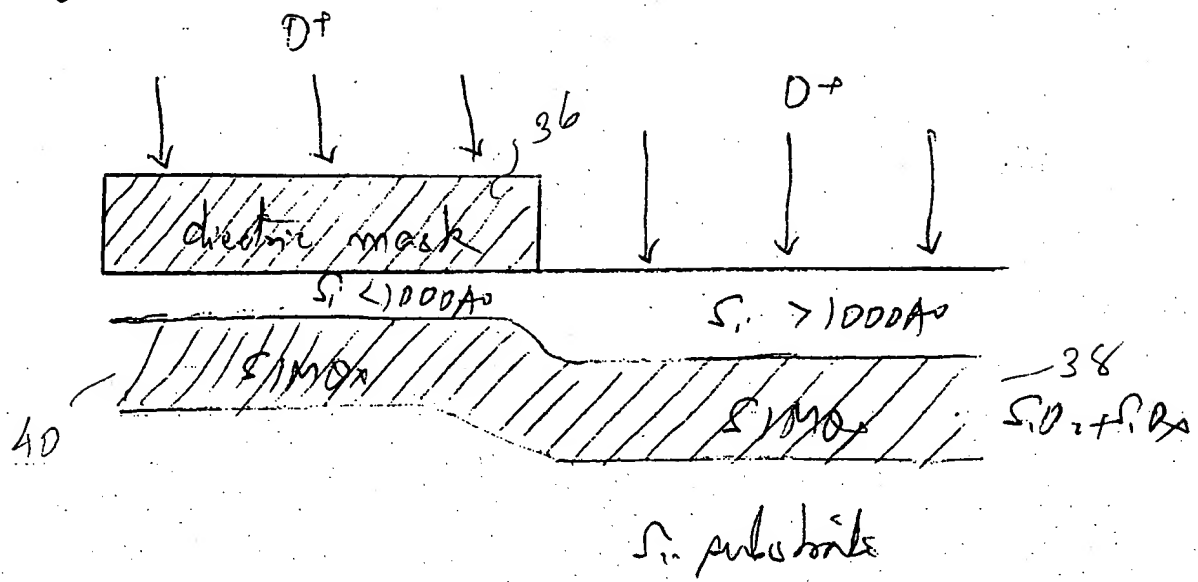
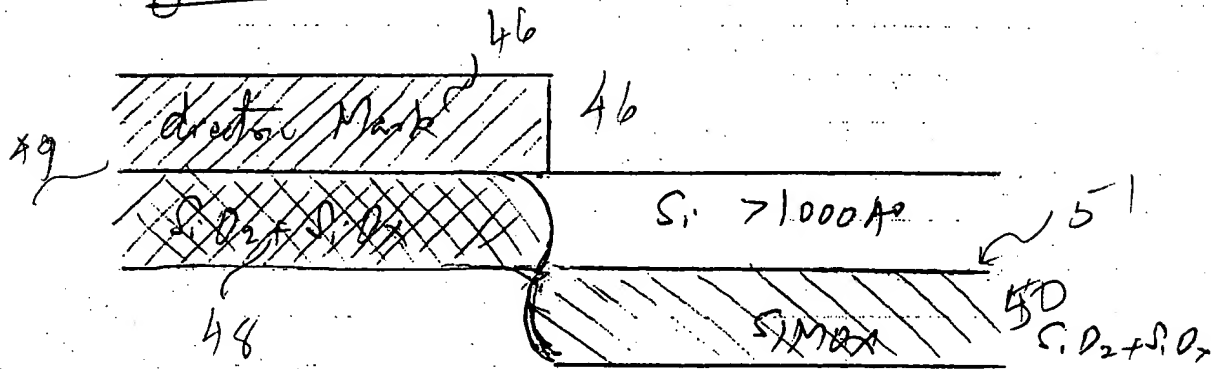
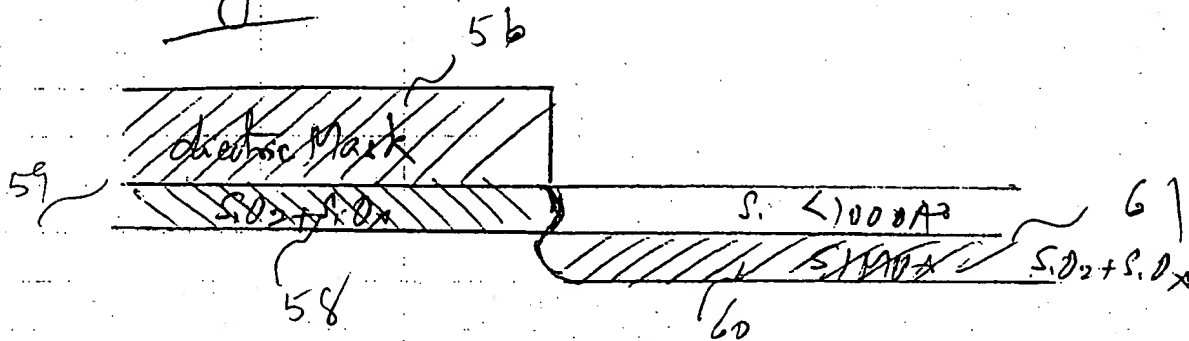


Figure 4



Si substrate

Fig. 5



Si substrate

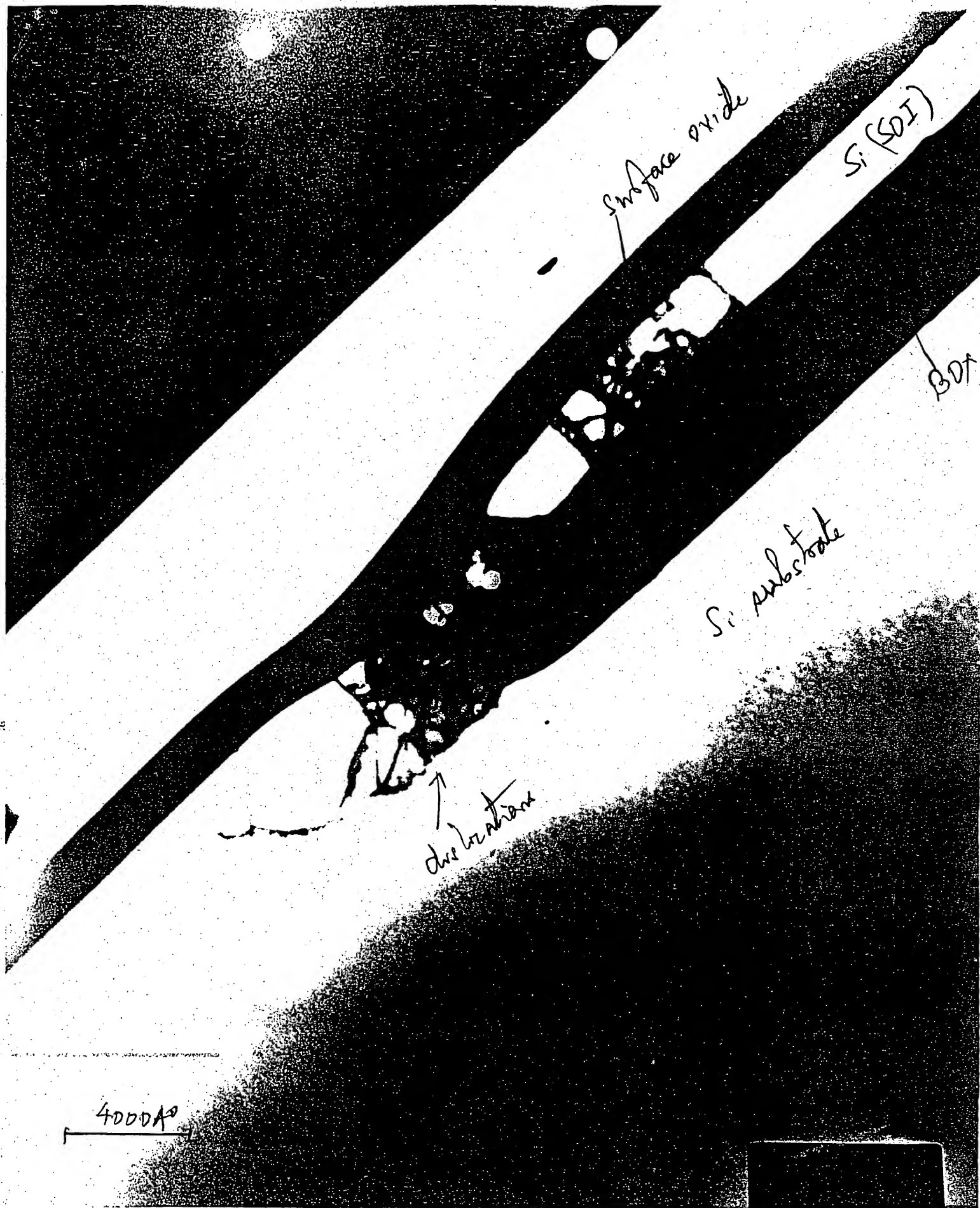


Figure 6



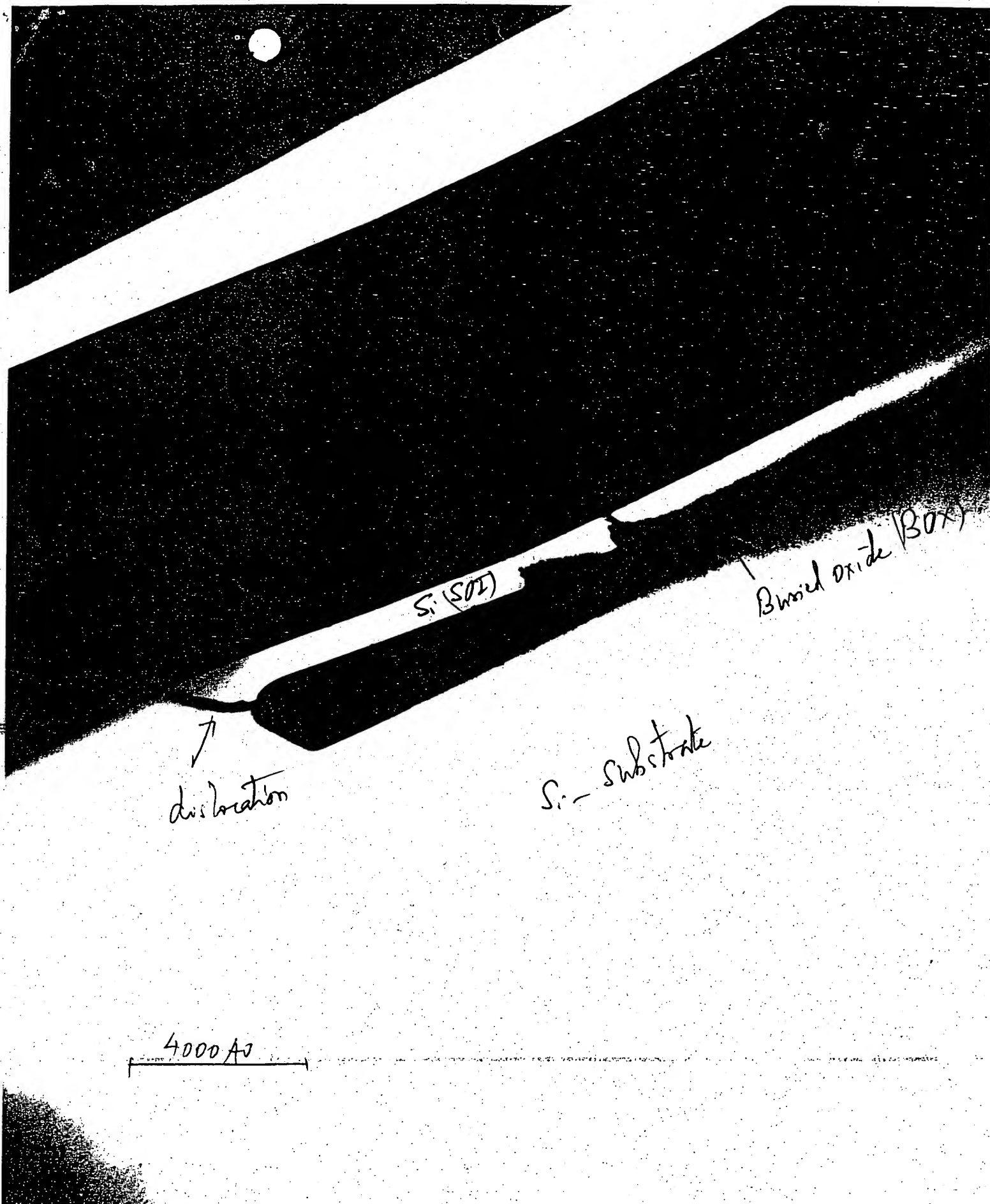


Figure 7